JC07 Rec'd PCT/PTO 19 DEC 2001

FORM PTO-1390 (Modified) REV 11-2000) U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371		ATTORNEY'S DOCKET NUMBER 112740-374
		U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR 10/019576
INTERNATIONAL APPLICATION NO. PCT/DE00/01542	INTERNATIONAL FILING DATE 16 May ~~2001~~ 2000	PRIORITY DATE CLAIMED 23 June 1999

TITLE OF INVENTION

METHOD FOR CONTROLLING THE TRANSMISSION POWER IN A RADIO SYSTEM, AND A CORRESPONDING RADIO SYSTEM

APPLICANT(S) FOR DO/EO/US

Bernhard Raaf

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include itens (5), (6), (9) and (24) indicated below.
4. ☒ The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. ☒ A copy of the International Application as filed (35 U.S.C. 371 (c) (2))
   - a. ☒ is attached hereto (required only if not communicated by the International Bureau).
   - b. ☐ has been communicated by the International Bureau.
   - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☒ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
   - a. ☒ is attached hereto.
   - b. ☐ has been previously submitted under 35 U.S.C. 154(d)(4).
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371 (c)(3))
   - a. ☐ are attached hereto (required only if not communicated by the International Bureau).
   - b. ☐ have been communicated by the International Bureau.
   - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   - d. ☒ have not been made and will not be made.
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)).
10. ☒ An English language translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)).
11. ☒ A copy of the International Preliminary Examination Report (PCT/IPEA/409).
12. ☒ A copy of the International Search Report (PCT/ISA/210).

Items 13 to 20 below concern document(s) or information included:

13. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
14. ☒ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
15. ☒ A **FIRST** preliminary amendment.
16. ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
17. ☒ A substitute specification.
18. ☐ A change of power of attorney and/or address letter.
19. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825.
20. ☐ A second copy of the published international application under 35 U.S.C. 154(d)(4).
21. ☐ A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
22. ☒ Certificate of Mailing by Express Mail
23. ☐ Other items or information:

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U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR) 10/019576	INTERNATIONAL APPLICATION NO. PCT/DE00/01542	ATTORNEY'S DOCKET NUMBER 112740-374

24. The following fees are submitted:.

BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :

		CALCULATIONS	PTO USE ONLY
☐ Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO	**$1040.00**		
☒ International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO	**$890.00**		
☐ International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO	**$740.00**		
☐ International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4)	**$710.00**		
☐ International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4)	**$100.00**		
ENTER APPROPRIATE BASIC FEE AMOUNT =		**$890.00**	
Surcharge of **$130.00** for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (e)).		**$0.00**	

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	21 - 20 =	1	x $18.00	**$18.00**	
Independent claims	2 - 3 =	0	x $84.00	**$0.00**	
Multiple Dependent Claims **(check if applicable).**			☐	**$0.00**	
TOTAL OF ABOVE CALCULATIONS =				**$908.00**	
☐ Applicant claims small entity status. See 37 CFR 1.27). The fees indicated above are reduced by 1/2.				**$0.00**	
SUBTOTAL =				**$908.00**	
Processing fee of **$130.00** for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (f)). +				**$0.00**	
TOTAL NATIONAL FEE =				**$908.00**	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31) **(check if applicable).**			☐	**$0.00**	
TOTAL FEES ENCLOSED =				**$908.00**	
				Amount to be: refunded	$
				charged	$

a. ☒ A check in the amount of **$908.00** to cover the above fees is enclosed.

b. ☐ Please charge my Deposit Account No. ____________ in the amount of ____________ to cover the above fees A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. **02-1818** A duplicate copy of this sheet is enclosed.

d. ☐ Fees are to be charged to a credit card. **WARNING:** Information on this form may become public. **Credit card information should not be included on this form.** Provide credit card information and authorization on PTO-2038.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

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WEV

SIGNATURE

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NAME

39,056

REGISTRATION NUMBER

December 19, 2001

DATE

10/019576

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BOX PCT

IN THE UNITED STATES ELECTED/DESIGNATED OFFICE
OF THE UNITED STATES PATENT AND TRADEMARK OFFICE
UNDER THE PATENT COOPERATION TREATY-CHAPTER II

PRELIMINARY AMENDMENT

APPLICANT: Bernhard Raaf . DOCKET NO: 112740-374

SERIAL NO: GROUP ART UNIT:

EXAMINER:

INTERNATIONAL APPLICATION NO: PCT/DE00/01542

INTERNATIONAL FILING DATE: 16 May 2001

INVENTION: METHOD FOR CONTROLLING THE TRANSMISSION POWER IN A RADIO SYSTEM, AND A CORRESPONDING RADIO SYSTEM

Assistant Commissioner for Patents,
Washington, D.C. 20231

Sir:

Please amend the above-identified International Application before entry into the National stage before the U.S. Patent and Trademark Office under 35 U.S.C. §371 as follows:

In the Specification:

Please replace the Specification of the present application, including the Abstract, with the following Substitute Specification:

SPECIFICATION

TITLE OF THE INVENTION

METHOD FOR CONTROLLING THE TRANSMISSION POWER IN A RADIO SYSTEM, AND A CORRESPONDING RADIO SYSTEM

BACKGROUND OF THE INVENTION

Control of the transmission power represents an important performance feature in mobile radio systems in order to suppress possible interference between the individual connections and, thus, to make it possible to improve the capacity and quality of the connections, in order to be able to reduce the mean transmission

power and to be able to match it as well as possible to the requirements, as well as to make it possible to compensate, at least partially, for losses in the transmission channels.

For this purpose, the signal transmitted by a transmitter is evaluated at the receiving end in the mobile radio system, in order to make it possible for this to produce information for power control and to transmit this to the transmitter, which then adjusts the transmission power in accordance with the power control or power adjustment information.

In this case, the power adjustment information is transmitted analogously to the transmission of the actual communication information, depending on the respective mobile radio system, embedded in a predetermined frame and timeslot structure; that is to say, the information is transmitted in a number of sequentially transmitted frames, with each frame having a specific number of timeslots. For known mobile radio systems, it has been proposed for the transmitter of the mobile radio system to be operated in a mode which is referred to as the slotted mode or compressed mode, with the information to be transmitted in this case being transmitted within specific frames in compressed form to a receiver in order to make it possible, in the appropriate frame, to produce a section which is free of information bits, and which is referred to as an idle slot, which can then be used for intermediate frequency measurements; for example, in order to prepare for a handover between different mobile radio systems. The information must be transmitted in a shorter time interval for compression.

The principle of compression is illustrated schematically in Figure 4, with a number of sequentially transmitted frames 3 being shown, each of which has an identical frame duration; for example, 10 ms. The second frame 3 shown in Figure 4 uses the slotted mode, that is to say the information is transmitted in compressed form in this frame, so that an idle slot 9 occurs in which information is now transmitted. As is likewise shown in Figure 4, the transmission power can be increased during this frame 3 that is operated in the slotted mode in order to achieve a transmission quality which is not adversely affected by the slotted mode.

However, the slotted mode interrupts the principle of fast power control. In modern mobile radio systems, power adjustment information for the transmitter is produced in each timeslot so that the transmission power can be adapted relatively quickly. However, no such power adjustment information can be transmitted during the idle slots described above. Firstly, this results in a higher error rate for the power adjustment information bits and, secondly, it must be expected that the instantaneous transmission power will deviate to a greater extent from the nominal value.

In order to overcome this problem associated with the slotted mode, it has been proposed, for example, to temporally increase the energy in what are referred to as pilot bits after the slotted mode, for power control, in order to allow correct decoding of the power adjustment information which is generally formed only by a corresponding bit with a specific mathematical sign. The pilot bits are used to estimate the channel impulse response during what is referred to as a training sequence, and they correspond to a known bit pattern. The power control procedure for the slotted mode as described in this document is, however, relatively complicated and requires a relatively large amount of effort.

The present invention is, thus, directed toward an improved method for controlling the transmission power in a radio system, and a corresponding radio system, in which case the aim is to reliably control the transmission power, particularly, in the slotted mode or compressed mode described above.

SUMMARY OF THE INVENTION

The present invention proposes that the same power adjustment information be transmitted in successive timeslots, so that the transmission power in the transmitter can be set with greater reliability, by evaluating the power adjustment information received during these timeslots in combination in order to adjust the transmission power.

The present invention is particularly suitable for use in what is referred to as the slotted mode, in which case the same power adjustment information is transmitted a number of times following an idle slot; that is to say, a section of a frame in which no information is transmitted. However, the present invention is

not restricted to this use in the slotted mode and can, in principle, be used also for timeslots which do not follow an idle slot in order to allow more reliable power control in these situations as well. In this case, this approach is of particular interest when the transmission conditions in the respective transmission channel are not changing rapidly (for example, when a mobile station is moving at slow speed).

In particular, the present invention proposes that the signal-to-noise ratio of the received signal be evaluated, for example, after an idle slot, that appropriate power adjustment information be produced as a function of this, and that this information be transmitted to the transmitter during the next two timeslots immediately following the idle slot. The transmitter then evaluates the power adjustment information received during these two timeslots and adjusts the transmission power taking account of both power adjustment information items so that a transmission power adjustment which may have been made on the basis of the first power adjustment information item can still be corrected.

The principle on which the present invention is based can be used both in the uplink, that is to say for transmitting communication information from a mobile station to a base station, and in the downlink, that is to say for the opposite direction, or else for both directions at the same time.

After receiving the power adjustment information in the first timeslot immediately following the idle slot, the transmission power initially can be kept constant so that no change is made until the power adjustment information in the second timeslot has been received.

Generally, the power adjustment information transmitted during each timeslot includes only one bit with the step width for changing the transmission power being coded digitally. However, instead of this, the step width also can be coded in analogue form; that is, the step width then depends, for example, directly analogously on the discrepancy between the received signal level measured in the receiver and a predetermined reference value.

The present invention requires no change whatsoever to the specified timeslot format. The combination of the successively transmitted power adjustment information items results in an improvement in the available bit-signal-noise ratio

(E_b/N_0). This increased bit-signal-noise ratio allows a greater step width to be provided for power control without any risk of an increased bit error rate more frequently resulting in the transmission power needing to be changed in the wrong direction.

The present invention can be used in various types of radio systems, although it is of particular interest for mobile radio systems using code division multiplexing methods (code division multiple access CDMA).

Additional features and advantages of the present invention are described in, and will be apparent from, the following Detailed Description of the Invention and the Figures.

BRIEF DESCRIPTION OF THE FIGURES

Figure 1 shows an illustration to explain the principle on which the present invention is based, on the basis of a preferred exemplary embodiment.

Figure 2 shows a general schematic illustration to explain the information transmission in a mobile radio system.

Figure 3 shows the frame and timeslot structure for what is referred to as a downlink connection, according to the present standard of UMTS Standardization.

Figure 4 shows an illustration to explain the frame structure in what is referred to as the slotted mode.

DETAILED DESCRIPTION OF THE INVENTION

The principle of power control will first of all be explained in more detail with reference to Figure 2. Figure 2 illustrates the communication between a base station 1 and a mobile station 2 in a mobile radio system. A connection from the base station 1 to the mobile part 2 is referred to as a downlink or forward link, while a connection from the mobile part 2 to the base station 1 is referred to as an uplink or reverse link. For downlink power control, the respective received signal is evaluated in the mobile station 2, and power adjustment information or power control information is produced as a function of it, and is sent back to the base station 1 so that the base station 1 can set the transmission power as appropriate. For uplink control, the received signal is evaluated in the base station 1, where the

power control information is produced, and the mobile station 2 is instructed to carry out power adaptation.

The power control information is, in this case, transmitted embedded in a predetermined frame structure depending on the respective mobile radio system.

As an example, Figure 3 shows the frame and timeslot structure for a downlink connection in a mobile radio system which is operated using a code division multiple access method (CDMA). The frame and timeslot structure shown in Figure 3 corresponds, in particular, to a UMTS mobile radio channel (Universal Mobile Telecommunications System), which is also referred to as a DPCH (Dedicated Physical CHannel), in accordance with the current state of UMTS Standardization. UMTS is the designation for third-generation mobile radio systems, aiming to provide a worldwide, universal mobile radio standard. According to the UMTS mobile radio standard, the multiple access method is what is referred to as the WCDMA method (Wideband Code Division Multiple Access).

The frame structure shown in Figure 3 has a duration of 720 ms and includes, in particular, 72 identically constructed frames 3 with a frame duration of 10 ms, with each frame, in turn, having 16 timeslots 4, each with a timeslot duration of 0.625 ms. Alternatively, a frame 3 may also include 15 correspondingly longer timeslots 4. However, the former situation is assumed in the following text. Each timeslot 4 includes information which is split between a logical control channel (DPCCH, Dedicated Physical Control Channel) and a logical data channel (DPDCH, Dedicated Physical Data Channel). The DPCCH section includes a pilot bit sequence 5 and what is referred to as TPC information (Transmitter Power Control) 6 and TFI information (Transmitter Format Identifier) 7. The DPDCH section includes user data bits 8.

The pilot bit sequence 5 is used for estimating the channel impulse response during what is referred to as a training sequence, and corresponds to a known bit pattern. The receiver can determine or estimate the channel impulse response of the mobile radio channel by comparing the received signal with the known pilot bit sequence.

The TFI information 7 is used for format identification for the respective receiver. The TFI bits are protected via their own coding method in accordance with the present WCDMA standard, and are distributed over an entire frame (time period 10 ms) by interleaving. If, for example, the TFI information 7 in each timeslot includes two bits, then this results in a total of 2*16 = 32 TFI bits per frame, which includes 16 timeslots, and these are coded via what is referred to as a biorthogonal coding method.

The TPC information 6 represents the command, produced by the receiver and transmitted to the transmitter, to adjust the transmission power. For this purpose, the received power or the signal-to-noise ratio of the received signal is compared with a predetermined reference value in the receiver, and the value for the power adjustment command is determined as a function of the discrepancy. As such, if the received power exceeds the reference value, a command is produced to reduce the transmission power, while a command to increase the transmission power is produced if the received power is less than the predetermined reference value. Thus, depending on the comparison result, the receiver transmits a digital or binary adjustment command to the transmitter. In this case, a command to increase the transmission power (power up command) is coded by a 1, while a command to reduce the transmission power (power down command) is coded by a zero. In each case, the adjustment command is transmitted to the transmitter after appropriate modulation. In accordance with the currently discussed WDCMA Standard for UMTS mobile radio systems, the transmission is carried out via QPSK modulation (Quadrature Phase Shift Keying), as a result of which the binary 1 or 0, respectively, is mapped onto the value -1 or +1, respectively, with subsequent spreading of the power control signal.

The power adjustment or power control information, thus, generally includes only one bit, which indicates whether the transmission power should be increased or decreased at the transmission end. In order to allow this bit to be transmitted with a sufficiently low error probability, the bit is transmitted repeatedly within the TPC field 6. The TPC information shown in Figure 3, in

consequence, includes, for example, the three bits which are transmitted successively with identical information content.

However, despite the repeated transmission of the TPC bits within the TPC field 6, the error rate is increased by the previously described slotted mode or compressed mode. In order to counteract this, information 6 is to be transmitted repeatedly, with this being done especially during the two timeslots 4 which immediately follow the idle slot 9.

In order to explain this principle, Figure 1 shows, by way of example, the structure of the already previously mentioned DPCCH control channel (see Figure 3) in a frame, assuming that the timeslots #n shown in Figure 1, is the timeslot immediately following is an idle slot; that is to say, a section which is not filled with information. The profile of the transmission power, which is set in the transmitter as a function of the respectively transmitted TPC information, is shown underneath the timeslot structure.

In the receiver, the signal-to-noise ratio of the signal being received from the transmitter at that time is measured in order to determine the TPC or power adjustment information to be transmitted during the timeslot #n is compared with a reference value and is used to produce the TPC information TPC_n. This TPC information is transmitted to the transmitter during the timeslot #n where it is decoded and used to adjust the transmission power. In this case, it is possible to wait first of all in the transmitter for reception of the TPC information TPC_{n+1} transmitted during the next timeslot #n+1, before finally setting the transmission power to the desired value, so that it is recommended that the transmission power initially be set in the transmitter in accordance with a "normal" nominal step width which corresponds to a normal E_b/N_0 ratio after receiving the TPC information TPC_n. This step width is indicated by ΔP_n in Figure 1, and corresponds to the difference between the instantaneous transmission power P_{n-1} and the transmission power P_n set after reception of the TPC information TPC_n. The value 0 may also be chosen as the step width ΔP_n after reception of the power adjustment information TPC_n in order to keep the transmission power constant until the power adjustment

information TPC_{n+1} is received, since it is then possible to make a decision on the transmission power to be set with greater reliability.

In order to produce the TPC information to be transmitted during the next timeslot #n+1, the TPC information from the previous timeslot is simply repeated, that is to say $TPC_{n+1} = TPC_n$, rather than evaluating the signal-to-noise ratio of the transmission signal once again. In this way, the ratio E_b/N_0 can be increased since, after receiving the timeslot #n+1, the TPC information TPC_{n+1} can be combined with the already previously received TPC information TPC_n, and the transmitter is thus able to set the transmission power to the desired value with greater reliability. If, for example, the transmitter identifies the fact that the decision made as a consequence of the most recently received TPC information was incorrect, this can now be corrected. As shown in Figure 1, the transmitter can now also change the transmission power with a larger step width, thus reducing the risk of a further deterioration being caused after an incorrect TPC decision. This is indicated in Figure 1 by ΔP_{n+1}, with both ΔP_n and ΔP_{n+1} indicating the step width with respect to the transmission power P_{n-1} set after the idle slot.

The principle, mentioned above, of repeated transmission of the same TPC information during successive timeslots can be applied not only to the first time after an interruption in the power control by the idle slot, but also during a normal connection. In this case, this is of particular interest for those situations in which the transmission channel does not change so fast with time, since the disadvantage, associated with the method, of an increased delay in the power control can then be more than compensated for by the advantage of better quality of the transmitted power adjustment information. Since the smallest step width for power control is currently 1 dB and, for implementation reasons, smaller values are not suitable for use in mobile stations, this provides a possible way to reduce the power control rate.

Furthermore, the present invention can be used to transmit the power adjustment information with a smaller number of TPC bits. Although this reduces the bit-signal-noise ratio (E_b/N_0), this can be compensated for by increased transmission reliability. The use of a small number of TPC bits is advantageous to

the extent that this reduces what is referred to as the overhead, and the efficiency can thus be improved.

Furthermore, the present invention also can be used for what is referred to as a soft handover. In this case, the mobile station 2 transmits and receives data from and to a number of base stations 1. To detect the user data, the received signals from all the connections are combined, thus allowing the power of each individual connection to be reduced. The TPC power adjustment commands may, however, in general not be combined since the TPC power adjustment commands sent from different base stations 1 (via a downlink) need not be identical. Since the TPC power adjustment commands also must be evaluated very quickly, it is also generally impossible to combine them in the uplink. Otherwise, intolerable delays would occur caused by the corresponding information being passed on from one base station 1 to another base station 1. In addition to increasing the power level of the number of TPC bits, this could be overcome by use of the present invention.

Finally, the previously described invention can also be combined with the principle of analogue transmission of the step width for adjustment of the transmission power. In this case, the transmission power to be set in the transmitter and the corresponding step width are coded in analogue form rather than digitally. That is, the power adjustment information is in each case set in analogue form depending on the discrepancy between the measured received signal level and the predetermined reference value; for example, the pilot bit reception level. A discrepancy that is twice as great between the received signal level and the reference value thus results in a step width which is twice as large.

Although the present invention has been described with reference to specific embodiments, those of skill in the art will recognize that changes may be made thereto without departing from the spirit and scope of the invention as set forth in the hereafter appended claims.

ABSTRACT OF THE DISCLOSURE

In a radio system, the transmission power is controlled by a receiver evaluating the signal from a transmitter and a determining power adjustment information as a function of this, and sending this information to the transmitter during successive timeslots, in order to control the transmission power. In what is referred to as the slotted mode, the same power adjustment information is transmitted to the transmitter in a number of successive timeslots following a section which is not filled with information.

In the Claims:

On page 13, cancel line 1 and substitute the following left-hand justified heading therefore:

CLAIMS

Please cancel the claims 1-21, without prejudice, and substitute the following claims therefore:

22. A method for controlling transmission power in a radio system, the method comprising the steps of:

transmitting information, embedded in a frame and a time slot structure, between and transmitter and a receiver;

evaluating a signal, which is received by the receiver from the transmitter via a transmission channel in the radio system;

producing power adjustment information as a function of the evaluated signal in each time slot and sending the power adjustment information to the transmitter;

adjusting the transmission power in the transmitter as a function of the power adjustment information; and

transmitting identical power adjustment information from the receiver to the transmitter in a plurality of successive timeslots.

23. A method for controlling transmission power in a radio system as claimed in claim 22, wherein the information is transmitted in compressed form in a specific frame such that a section of the frame is not filled with information and, following the section which is not filled with information, the receiver transmits identical power adjustment information to the transmitter in a plurality of successive timeslots.

24. A method for controlling transmission power in a radio system as claimed in claim 23, wherein, following the section which is not filled with

information, the receiver transmits identical power adjustment information to the transmitter in two successive first and second timeslots.

25. A method for controlling transmission power in a radio system as claimed in claim 24, wherein the transmission power in the transmitter is adjusted as a function of both power adjustment information received in the first timeslot following the section which is not filled with information and power adjustment information received in a second section following the section which is not filled with information.

26. A method for controlling transmission power in a radio system as claimed in claim 24, wherein the signal received by the receiver from the transmitter is evaluated once again only after the transmission of the identical power adjustment information in the first and second time slots following the section which is not filled with information, and new power adjustment information is produced as a function of the re-evaluated signal and is sent to the transmitter in a next timeslot.

27. A method for controlling transmission power in a radio system as claimed in claim 24, wherein the transmission power in the transmitter is adjusted by a fixed amount after receiving the power adjustment information transmitted in the first timeslot following the section which is not filled with information, and after receiving the power adjustment information transmitted during the second timeslot following the section which is not filled with information, and taking account of the power adjustment information transmitted during the first time slot following the section which is not filled with information, a power change value is determined, and the transmission power in the transmitter is adjusted in accordance with the power change value relative to the transmission power set prior to the first adjustment.

28. A method for controlling transmission power in a radio system as claimed in claim 27, wherein the fixed amount corresponds to a value of zero.

29. A method for controlling transmission power in a radio system as claimed in claim 22, wherein, in the receiver, the power adjustment information is produced analogously as a function of a discrepancy between a specific evaluated parameter in the received signal and a corresponding reference value.

30. A method for controlling transmission power in a radio system as claimed in claim 23, wherein identical power adjustment information is transmitted to the transmitter in a plurality of successive timeslots which do not immediately follow the section which is not filled with information, and the transmission power in the transmitter is adjusted taking account of the power adjustment information received during the plurality of successive timeslots.

31. A method for controlling transmission power in a radio system as claimed in claim 23, wherein identical power adjustment information is transmitted to the transmitter a plurality of times in successive timeslots following the section which is not filled with information, with a plurality of repetitions being different each time.

32. A method for controlling transmission power in a radio system as claimed in claim 22, wherein the method is used during a soft handover in the mobile radio system.

33. A radio system, comprising:

a transmitter; and

a receiver for receiving a signal, which is transmitted from the transmitter via a transmission channel in the radio system, and for evaluating the received signal in order to produce power adjustment information as a function of

the received signal, and to send the power adjustment information to the transmitter;

wherein the transmitter adjusts the transmission power as a function of the power adjustment information received from the receiver, with information being transmitted, embedded in a frame and a timeslot structure, between the transmitter and the receiver with a signal, the receiver transmitting identical power adjustment information to the transmitter in a plurality of successive time slots.

34. A radio system as claimed in claim 33, wherein the information is transmitted in compressed form in a specific frame, such that there is a section of the frame which is not filled with information, the receiver transmitting identical power information to the transmitter in a plurality of successive time slots following the section which is not filled with information.

35. A radio system as claimed in claimed 34, wherein the receiver transmits identical power adjustment information to the transmitter to the transmitter in two successive first and second timeslots following the section which is not filled with information.

36. A radio system as claimed in claimed 35, wherein the transmitter adjusts the transmission power as a function of both power adjustment information received in the first time slot following the section which is not filled with information and power adjustment information received in a second section following the section which is not filled with information.

37. A radio system as claimed in claimed 35, wherein the receiver once again evaluates the signal, received by the receiver from the transmitter after the transmission of the identical power adjustment information in the first and second time slots following the section which is not filled with information, and produces new power adjustment information as a function of the re-evaluated signal, and sends the new power adjustment information to the transmitter in a next timeslot.

38. A radio system as claimed in claim 35, wherein the transmitter changes the transmission power by a fixed amount after receiving the power adjustment information transmitted in the first timeslot following the section which is not filled with information and, after receiving the power adjustment information received during the second timeslot following the section which is not filled with information and additionally taking account of the power adjustment information received during the first timeslot following the section which is not filled with information, determines a power change and changes the transmission power in the transmitter in accordance with the power change value.

39. A radio system as claimed in claim 38, wherein the fixed amount corresponds to a value of zero such that after receiving the power adjustment information transmitted in the first timeslot following the section which is not filled with information, the transmitter keeps the transmission power constant until reception of the power adjustment information transmitted in the second timeslot following the section which is not filled with information.

40. A radio system as claimed in claim 33, wherein the receiver produces the power adjustment information analogously as a function of a discrepancy between a specific evaluated parameter in the received signal and a corresponding reference value.

41. A radio system as claimed in claim 34, wherein the receiver also transmits identical power adjustment information to the transmitter in a plurality of successive timeslots which do not directly follow a section which is not filled with information, and the transmitter adjusts the transmission power taking account of the power adjustment information received during the plurality of successive timeslots.

42. A radio system as claimed in claim 33, wherein the radio system is a CDMA mobile radio system.

REMARKS

The present amendment makes editorial changes and corrects typographical errors in the specification, which includes the Abstract, in order to conform the specification to the requirements of United States Patent Practice. No new matter is added thereby.

Attached hereto is a marked-up version of the changes made to the specification and claims by the current amendment. The attached page is captioned "**Versions with Markings to Show Changes Made.**"

In addition, the present amendment cancels original claims 1-21 in favor of new claims 22-42. Claims 22-42 have been presented solely because the revisions by crossing out underlining which would have been necessary in claims 1-21 in order to present those claims in accordance with preferred United States Patent Practice would have been too extensive, and thus would have been too burdensome. The present amendment is intended for clarification purposes only and not for substantial reasons related to patentability pursuant to 35 U.S.C. §§101, 102, 103 or 112. Indeed, the cancellation of claims 1-21 does not constitute an intent on the part of the Applicants to surrender any of the subject matter of claims 1-21.

Early consideration on the merits is respectfully requested.

Respectfully submitted,
BELL, BOYD & LLOYD LLC

BY ______________________

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

In the Specification:

SPECIFICATION

TITLE OF THE INVENTION

METHOD FOR CONTROLLING THE TRANSMISSION POWER IN A RADIO SYSTEM, AND A CORRESPONDING RADIO SYSTEM

~~Description~~

~~Method for controlling the transmission power in a radio system, and a corresponding radio system~~

~~The present invention relates to a method as claimed in the precharacterizing clause of claim 1 for controlling the transmission power in a radio system, and to a corresponding radio system as claimed in the precharacterizing clause of claim 12, in particular to a corresponding mobile radio system.~~

BACKGROUND OF THE INVENTION

Control of the transmission power represents an important performance feature in mobile radio systems~~,~~ in order to suppress possible interference between the individual connections~~,~~ and, thus, to make it possible to improve the capacity and quality of the connections, in order to be able to reduce the mean transmission power and to be able to match it as well as possible to the requirements, as well as to make it possible to compensate, at least partially, for losses in the transmission channels.

For this purpose, the signal transmitted by a transmitter is evaluated at the receiving end in the mobile radio system, in order to make it possible ~~to~~ for this to produce information for power control and to transmit this to the transmitter, which then adjusts the transmission power in accordance with the power control or power adjustment information.

In this case, the power adjustment information is transmitted analogously to the transmission of the actual communication information, depending on the respective mobile radio system, embedded in a predetermined frame and timeslot structure~~,~~; that is to say, the information is transmitted in a number of sequentially transmitted frames, with each frame having a specific number of timeslots. For

known mobile radio systems, it has been proposed for the transmitter of the mobile radio system to be operated in a mode which is referred to as the slotted mode or compressed mode, with the information to be transmitted in this case being transmitted within specific frames in compressed form to a receiver in order to make it possible, in the appropriate frame, to produce a section which is free of information bits, and which is referred to as an idle slot, which can then be used for intermediate frequency measurements~~,~~; for example, in order to prepare for a handover between different mobile radio systems. The information must be transmitted in a shorter time interval~~,~~ for compression.

The principle of compression is illustrated schematically in Figure 4, with a number of sequentially transmitted frames 3 being shown, each of which has an identical frame duration~~,~~; for example, 10 ms. The second frame 3 shown in Figure 4 uses the slotted mode, that is to say the information is transmitted in compressed form in this frame, so that an idle slot 9 occurs~~,~~ in which ~~now~~ information is now transmitted. As is likewise shown in Figure 4, the transmission power can be increased during this frame 3 that is operated in the slotted mode~~,~~ in order to achieve a transmission quality which is not adversely affected by the slotted mode.

However, the slotted mode interrupts the principle of fast power control. In modern mobile radio systems, power adjustment information for the transmitter is produced in each timeslot~~,~~ so that the transmission power can be adapted relatively quickly. However, no such power adjustment information can be transmitted during the idle slots described above. Firstly, this results in a higher error rate for the power adjustment information bits and, secondly, it must be expected that the instantaneous transmission power will deviate to a greater extent from the nominal value.

In order to overcome this problem associated with the slotted mode, it has been proposed, for example, to temporally increase the energy in what are referred to as pilot bits after the slotted mode, for power control, in order to allow correct decoding of the power adjustment information~~,~~ which is generally formed only by a corresponding bit with a specific mathematical sign. The pilot bits are used to estimate the channel impulse response during what is referred to as a training

sequence, and they correspond to a known bit pattern. The power control procedure for the slotted mode as described in this document is, however, relatively complicated~~,~~ and requires a relatively large amount of effort.

The present invention is, thus ~~based on the object of proposing~~, directed toward an improved method for controlling the transmission power in a radio system, and ~~of proposing~~ a corresponding radio system, in which case the aim is to reliably control the transmission power ~~in particular even~~, particularly, in the slotted mode or compressed mode described above.

~~According to the invention, this object is achieved by a method having the features of claim 1, and by a radio system having the features of claim 12. The depending claims each define preferred embodiments of the present invention.~~

SUMMARY OF THE INVENTION

The present invention proposes that the same power adjustment information be transmitted in successive timeslots, so that the transmission power in the transmitter can be set with greater reliability, by evaluating the power adjustment information received during these timeslots in combination in order to adjust the transmission power.

The present invention is particularly suitable for use in what is referred to as the slotted mode, in which case the same power adjustment information is transmitted a number of times following an idle slot~~,~~; that is to say, a section of a frame in which no information is transmitted. However, the present invention is not restricted to this use in the slotted mode~~, that is to say the invention~~ and can, in principle, ~~also~~ be used also for timeslots which do not follow an idle slot~~,~~ in order to allow more reliable power control in these situations as well. In this case, this approach is of particular interest when the transmission conditions in the respective transmission channel are not changing rapidly (for example, when a mobile station is moving at slow speed).

In particular, the present invention proposes that the signal-to-noise ratio of the received signal be evaluated, for example, after an idle slot, that appropriate power adjustment information be produced as a function of this, and that this information be transmitted to the transmitter during the next two timeslots

immediately following the idle slot. The transmitter then evaluates the power adjustment information received during these two timeslots and adjusts the transmission power taking account of both power adjustment information items~~,~~ so that a transmission power adjustment which may have been made on the basis of the first power adjustment information item can still be corrected.

The principle on which the present invention is based can be used both in the uplink, that is to say for transmitting communication information from a mobile station to a base station, and in the downlink, that is to say for the opposite direction, or else for both directions at the same time.

After receiving the power adjustment information in the first timeslot immediately following the idle slot, the transmission power ~~can~~ initially can be kept constant~~,~~ so that no change is made until the power adjustment information in the second timeslot has been received.

Generally, the power adjustment information transmitted during each timeslot ~~comprises~~ includes only one bit~~,~~ with the step width for changing the transmission power being coded digitally. However, instead of this, the step width ~~can~~ also can be coded in analogue form~~,~~; that is, ~~to say~~ the step width then depends, for example, directly analogously on the discrepancy between the received signal level measured in the receiver and a predetermined reference value.

The present invention requires no change whatsoever to the specified timeslot format. The combination of the successively transmitted power adjustment information items results in an improvement in the available bit-signal-noise ratio (E_b/N_0). This increased bit-signal-noise ratio allows a greater step width to be provided for power control without any risk of an increased bit error rate more frequently resulting in the transmission power needing to be changed in the wrong direction.

The present invention can be used in various types of radio ~~system,~~ systems, although ~~the present invention~~ it is of particular interest for mobile radio systems using code division multiplexing methods (code division multiple access CDMA).

~~The invention will be explained in more detail in the following text with reference to the drawing, based on preferred exemplary embodiments.~~

Additional features and advantages of the present invention are described in, and will be apparent from, the following Detailed Description of the Invention and the Figures.

BRIEF DESCRIPTION OF THE FIGURES

Figure 1 shows an illustration to explain the principle on which the present invention is based, on the basis of a preferred exemplary embodiment~~,~~.

Figure 2 shows a general schematic illustration to explain the information transmission in a mobile radio system~~,~~.

Figure 3 shows the frame and timeslot structure for what is referred to as a downlink connection, according to the present standard of UMTS Standardization~~,~~ ~~and~~.

Figure 4 shows an illustration to explain the frame structure in what is referred to as the slotted mode.

DETAILED DESCRIPTION OF THE INVENTION

The principle of power control will first of all be explained in more detail with reference to Figure 2~~, with~~. Figure 2 ~~illustrating~~ illustrates the communication between a base station 1 and a mobile station 2 in a mobile radio system. A connection from the base station 1 to the mobile part 2 is referred to as a downlink or forward link, while a connection from the mobile part 2 to the base station 1 is referred to as an uplink or reverse link. For downlink power control, the respective received signal is evaluated in the mobile station 2, and power adjustment information or power control information is produced as a function of it, and is sent back to the base station 1~~,~~ so that the base station 1 can set the transmission power as appropriate. For uplink control, the received signal is evaluated in the base station 1, where the power control information is produced, and the mobile station 2 is instructed to carry out power adaptation.

The power control information is, in this case, transmitted embedded in a predetermined frame structure~~,~~ depending on the respective mobile radio system.

As an example, Figure 3 shows the frame and timeslot structure for a downlink connection in a mobile radio system which is operated using a code division multiple access method (CDMA). The frame and timeslot structure shown

in Figure 3 corresponds, in particular, to a UMTS mobile radio channel (Universal Mobile Telecommunications System), which is also referred to as a DPCH (Dedicated Physical CHannel), in accordance with the current state of UMTS Standardization. UMTS is the designation for third-generation mobile radio systems, aiming to provide a worldwide, universal mobile radio standard. According to the UMTS mobile radio standard, the multiple access method is what is referred to as the WCDMA method (Wideband Code Division Multiple Access).

The frame structure shown in Figure 3 has a duration of 720 ms and ~~comprises~~ includes, in particular, 72 identically constructed frames 3 with a frame duration of 10 ms, with each frame, in turn, having 16 timeslots 4, each with a timeslot duration of 0.625 ms. Alternatively, a frame 3 may also ~~comprise~~ include 15 correspondingly longer timeslots 4. However, the former situation is assumed in the following text. Each timeslot 4 ~~comprises~~ includes information which is split between a logical control channel (DPCCH, Dedicated Physical Control Channel) and a logical data channel (DPDCH, Dedicated Physical Data Channel). The DPCCH section ~~comprises~~ includes a pilot bit sequence 5 and what is referred to ~~a~~ as TPC information (Transmitter Power Control) 6 and TFI information (Transmitter Format Identifier) 7. The DPDCH section ~~comprises~~ includes user data bits 8.

The pilot bit sequence 5 is used for estimating the channel impulse response during what is referred to as a training sequence, and corresponds to a known bit pattern. The receiver can determine or estimate the channel impulse response of the mobile radio channel by comparing the received signal with the known pilot bit sequence.

The TFI information 7 is used for format identification for the respective receiver. The TFI bits are protected ~~by means of~~ via their own coding method in accordance with the present WCDMA standard, and are distributed over an entire frame (time period 10 ms) by interleaving. If, for example, the TFI information 7 in each timeslot ~~comprises~~ includes two bits, then this results in a total of 2*16 = 32 TFI bits per frame, which ~~comprises~~ includes 16 timeslots, and these are coded ~~by means of~~ via what is referred to as a biorthogonal coding method.

The TPC information 6 represents the command, produced by the receiver and transmitted to the transmitter, to adjust the transmission power. For this purpose, the received power or the signal-to-noise ratio of the received signal is compared with a predetermined reference value in the receiver, and the value for the power adjustment command is determined as a function of the discrepancy. ~~This means that~~ As such, if the received power exceeds the reference value, a command is produced to reduce the transmission power, while a command to increase the transmission power is produced if the received power is less than the predetermined reference value. Thus, depending on the comparison result, the receiver ~~thus~~ transmits a digital or binary adjustment command to the transmitter. In this case, a command to increase the transmission power (power up command) is coded by a 1, while a command to reduce the transmission power (power down command) is coded by a zero. In each case, the adjustment command is transmitted to the transmitter after appropriate modulation. In accordance with the currently discussed WDCMA Standard for UMTS mobile radio systems, the transmission is carried out ~~by means of~~ via QPSK modulation (Quadrature Phase Shift Keying), as a result of which the binary 1 or 0, respectively, is mapped onto the value -1 or +1, respectively, with subsequent spreading of the power control signal.

The power adjustment or power control information, thus, generally ~~comprises~~ includes only one bit, which indicates whether the transmission power should be increased or decreased at the transmission end. In order to allow this bit to be transmitted with a sufficiently low error probability, the bit is transmitted repeatedly within the TPC field 6. The TPC information shown in Figure 3, in consequence, ~~comprises~~ includes, for example, the three bits which are transmitted successively with identical information content.

However, despite the repeated transmission of the TPC bits within the TPC field 6, the error rate is increased by the previously described slotted mode or compressed mode. In order to counteract this, ~~before [lacuna]~~ information 6 is to be transmitted repeatedly, with this being done especially during the two timeslots 4 which immediately follow the idle slot 9.

In order to explain this principle, Figure 1 shows, by way of example, the structure of the already previously mentioned DPCCH control channel (see Figure 3) in a frame, assuming that the timeslots #n shown in Figure 1, is the timeslot immediately following is an idle slot~~,~~; that is to say, a section which is not filled with information. The profile of the transmission power, which is set in the transmitter as a function of the respectively transmitted TPC information, is shown underneath the timeslot structure.

In the receiver, the signal-to-noise ratio of the signal being received from the transmitter at that time is measured in order to determine the TPC or power adjustment information to be transmitted during the timeslot #n~~,~~ is compared with a reference value and is used to produce the TPC information TPC_n. This TPC information is transmitted to the transmitter during the timeslot #n~~,~~ where it is decoded and used to adjust the transmission power. In this case, it is possible to wait first of all in the transmitter for reception of the TPC information TPC_{n+1} transmitted during the next timeslot #n+1, before finally setting the transmission power to the desired value, so that it is recommended that the transmission power initially be set in the transmitter in accordance with a "normal" nominal step width~~,~~ which corresponds to a normal E_b/N_0 ratio~~,~~ after receiving the TPC information TPC_n. This step width is indicated by ΔP_n in Figure 1, and corresponds to the difference between the instantaneous transmission power P_{n-1} and the transmission power P_n set after reception of the TPC information TPC_n. The value 0 may also be chosen as the step width ΔP_n after reception of the power adjustment information TPC_n~~,~~ in order to keep the transmission power constant until the power adjustment information TPC_{n+1} is received, since it is then possible to make a decision on the transmission power to be set~~,~~ with greater reliability.

In order to produce the TPC information to be transmitted during the next timeslot #n+1, the TPC information from the previous timeslot is simply repeated, that is to say $TPC_{n+1} = TPC_n$, rather than evaluating the signal-to-noise ratio of the transmission signal once again. In this way, the ratio E_b/N_0 can be increased since, after receiving the timeslot #n+1, the TPC information TPC_{n+1} can be combined with the already previously received TPC information TPC_n, and the transmitter is

thus able to set the transmission power to the desired value with greater reliability. If, for example, the transmitter identifies the fact that the decision made as a consequence of the most recently received TPC information was incorrect, this can now be corrected. As shown in Figure 1, the transmitter can now also change the transmission power with a larger step width, thus reducing the risk of a further deterioration being caused after an incorrect TPC decision. This is indicated in Figure 1 by ΔP_{n+1}, with both ΔP_n and ΔP_{n+1} indicating the step width with respect to the transmission power P_{n-1} set after the idle slot.

The principle, mentioned above, of repeated transmission of the same TPC information during successive timeslots can be applied not only to the first time after an interruption in the power control by the idle slot, but also during a normal connection. In this case, this is of particular interest for those situations in which the transmission channel does not change so fast with time, since the disadvantage, associated with the method, of an increased delay in the power control can then be more than compensated for by the advantage of better quality of the transmitted power adjustment information. Since the smallest step width for power control is currently 1 dB and, for implementation reasons, smaller values are not suitable for use in mobile stations, this provides a possible way to reduce the power control rate.

Furthermore, the present invention can be used to transmit the power adjustment information with a smaller number of TPC bits. Although this reduces the bit-signal-noise ratio (E_b/N_0), this can be compensated for~~, however, by the advantage of the invention, namely~~ by increased transmission reliability. The use of a small number of TPC bits is advantageous to the extent that this reduces what is referred to as the overhead, and the efficiency can thus be improved.

Furthermore, the present invention ~~can~~ also ~~advantageously~~ can be used for what is referred to as a soft handover. In this case, the mobile station 2 transmits and receives data from and to a number of base stations 1. To detect the user data, the received signals from all the connections are combined, thus allowing the power of each individual connection to be reduced. The TPC power adjustment commands may, however, in general not be combined~~,~~ since the TPC power

adjustment commands sent from different base stations 1 (via a downlink) need not be identical. Since the TPC power adjustment commands ~~must~~ also must be evaluated very quickly, it is also generally impossible to combine them in the uplink. Otherwise, intolerable delays would occur~~,~~ caused by the corresponding information being passed on from one base station 1 to another base station 1. In addition to increasing the power level of the number of TPC bits, this could be overcome by use of the present invention.

Finally, the previously described invention can also be combined with the principle of analogue transmission of the step width for adjustment of the transmission power. In this case, the transmission power to be set in the transmitter and the corresponding step width are coded in analogue form rather than digitally~~,~~ ~~that is to say~~. That is, the power adjustment information is in each case set in analogue form depending on the discrepancy between the measured received signal level and the predetermined reference value~~,~~; for example, the pilot bit reception level. A discrepancy that is twice as great between the received signal level and the reference value thus results in a step width which is twice as large.

Although the present invention has been described with reference to specific embodiments, those of skill in the art will recognize that changes may be made thereto without departing from the spirit and scope of the invention as set forth in the hereafter appended claims.

ABSTRACT OF THE DISCLOSURE

~~Abstract~~

~~Method for controlling the transmission power in a radio system, and a corresponding radio system~~

In a radio system, the transmission power is controlled by a receiver ~~(1; 2)~~ evaluating the signal from a transmitter ~~(2; 1)~~ and a determining power adjustment information ~~(TPC)~~ as a function of this, and sending this information to the transmitter ~~(2; 1)~~ during successive timeslots~~(4)~~, in order to control the transmission power. In what is referred to as the slotted mode, the same power adjustment information ~~(TPC)~~ is transmitted to the transmitter ~~(2; 1)~~ in a number of successive timeslots ~~(4)~~ following a section ~~(9)~~ which is not filled with information.

~~(Figure 1)~~

FIG 1

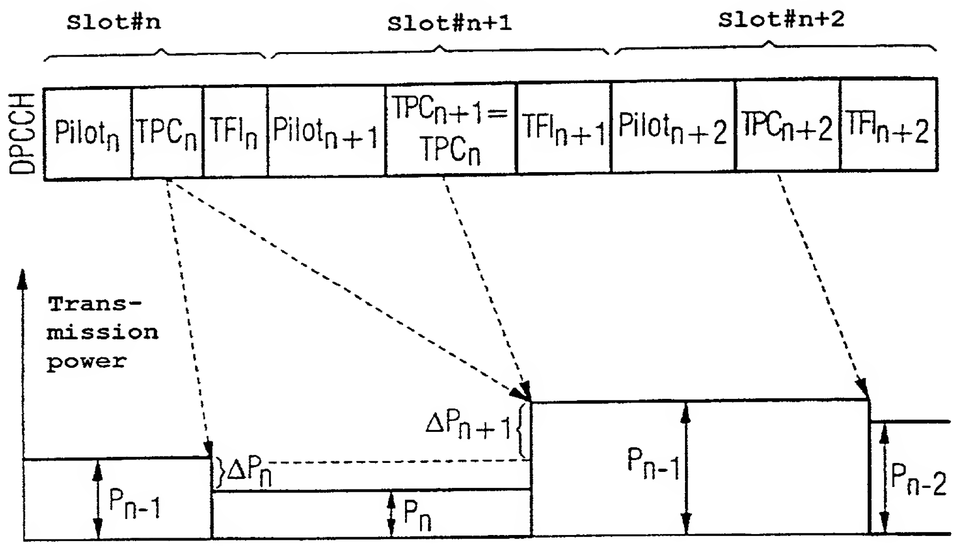

Slot#n
Slot#n+1
Slot#n+2
DPCCH
Pilotn
TPCn
TFIn
Pilotn+1
TPCn+1=
TPCn
TFIn+1
Pilotn+2
TPCn+2
TFIn+2
Trans-
mission
power
ΔPn+1
ΔPn
Pn-1
Pn
Pn-1
Pn-2

FIG 2

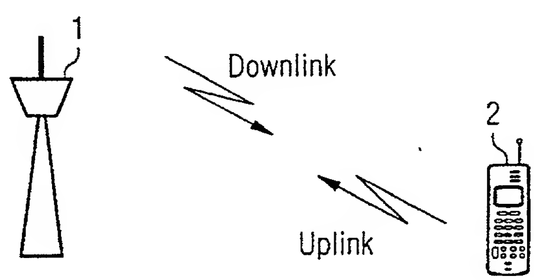

1
Downlink
2
Uplink

FIG 3

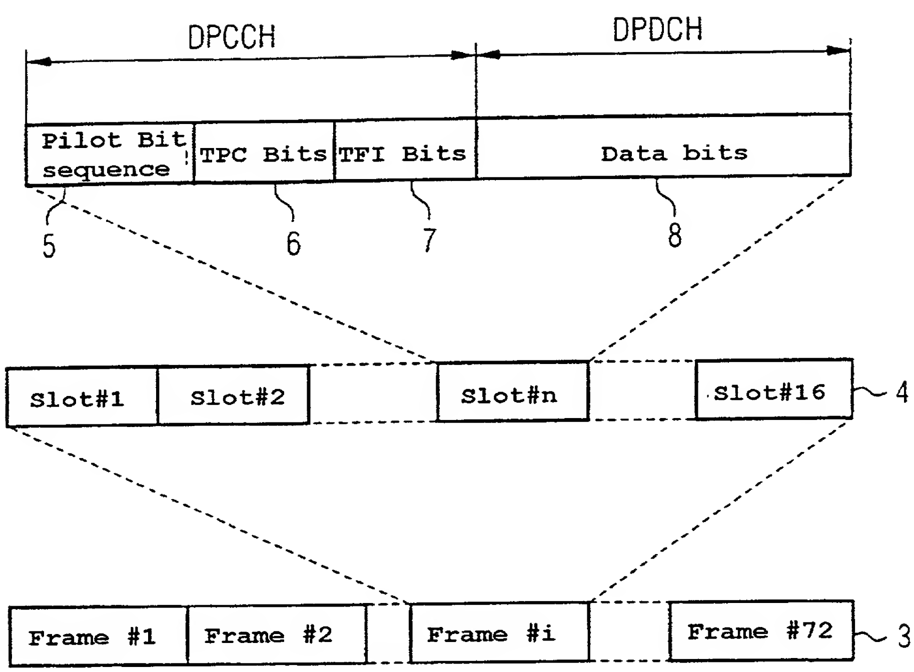
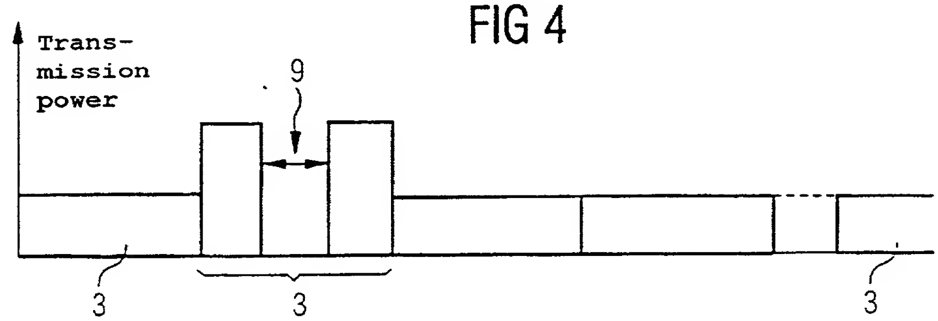

DPCCH
DPDCH
Pilot Bit sequence
TPC Bits
TFI Bits
Data bits
5
6
7
8
Slot#1
Slot#2
Slot#n
Slot#16
4
Frame #1
Frame #2
Frame #i
Frame #72
3

FIG 4


Trans-mission power
9
3
3
3

*

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531 Rec'd PCT/PTO 19 DEC 2001

GR 99 P 2101

Description

Method for controlling the transmission power in a radio system, and a corresponding radio system

The present invention relates to a method as claimed in the precharacterizing clause of claim 1 for controlling the transmission power in a radio system, and to a corresponding radio system as claimed in the precharacterizing clause of claim 12, in particular to a corresponding mobile radio system.

Control of the transmission power represents an important performance feature in mobile radio systems, in order to suppress possible interference between the individual connections, and thus to make it possible to improve the capacity and quality of the connections, in order to be able to reduce the mean transmission power and to be able to match it as well as possible to the requirements, as well as to make it possible to compensate, at least partially, for losses in the transmission channels.

For this purpose, the signal transmitted by a transmitter is evaluated at the receiving end in the mobile radio system, in order to make it possible to this to produce information for power control and to transmit this to the transmitter, which then adjusts the transmission power in accordance with the power control or power adjustment information.

In this case, the power adjustment information is transmitted analogously to the transmission of the actual communication information, depending on the

respective mobile radio system, embedded in a predetermined frame and timeslot structure, that is to say the information is transmitted in a number of sequentially transmitted frames, with each frame having a specific number of timeslots. For known mobile radio systems, it has been proposed for the transmitter of the mobile radio system to be operated in a mode which is referred to as the slotted mode or compressed mode, with the information to be transmitted in this case being transmitted within specific frames in

compressed form to a receiver in order to make it possible, in the appropriate frame, to produce a section which is free of information bits, and which is referred to as an idle slot, which can then be used for intermediate frequency measurements, for example in order to prepare for a handover between different mobile radio systems. The information must be transmitted in a shorter time interval, for compression.

The principle of compression is illustrated schematically in Figure 4, with a number of sequentially transmitted frames 3 being shown, each of which has an identical frame duration, for example 10 ms. The second frame 3 shown in Figure 4 uses the slotted mode, that is to say the information is transmitted in compressed form in this frame, so that an idle slot 9 occurs, in which now information is transmitted. As is likewise shown in Figure 4, the transmission power can be increased during this frame 3 that is operated in the slotted mode, in order to achieve a transmission quality which is not adversely affected by the slotted mode.

However, the slotted mode interrupts the principle of fast power control. In modern mobile radio systems, power adjustment information for the transmitter is produced in each timeslot, so that the transmission power can be adapted relatively quickly. However, no such power adjustment information can be transmitted during the idle slots described above. Firstly, this results in a higher error rate for the power adjustment information bits and, secondly, it must be expected

that the instantaneous transmission power will deviate to a greater extent from the nominal value.

In order to overcome this problem associated with the slotted mode, it has been proposed, for example, to temporally increase the energy in what are referred to as pilot bits after the slotted mode,

for power control, in order to allow correct decoding of the power adjustment information, which is generally formed only by a corresponding bit with a specific mathematical sign. The pilot bits are used to estimate the channel impulse response during what is referred to as a training sequence, and correspond to a known bit pattern. The power control procedure for the slotted mode as described in this document is, however, relatively complicated, and requires a relatively large amount of effort.

The present invention is thus based on the object of proposing an improved method for controlling the transmission power in a radio system, and of proposing a corresponding radio system, in which case the aim is to reliably control the transmission power in particular even in the slotted mode or compressed mode described above.

According to the invention, this object is achieved by a method having the features of claim 1, and by a radio system having the features of claim 12. The depending claims each define preferred embodiments of the present invention.

The invention proposes that the same power adjustment information be transmitted in successive timeslots, so that the transmission power in the transmitter can be set with greater reliability, by evaluating the power adjustment information received during these timeslots in combination in order to adjust the transmission power.

The invention is particularly suitable for use in what is referred to as the slotted mode, in which case the same power adjustment information is transmitted a number of times following an idle slot, that is to say a section of a frame in which no information is transmitted. However, the invention is not restricted to this use in the slotted mode, that is to say

the invention can in principle also be used for timeslots which do not follow an idle slot, in order to allow more reliable power control in these situations as well. In this case, this approach is of particular interest when the transmission conditions in the respective transmission channel are not changing rapidly (for example when a mobile station is moving at slow speed).

In particular, the invention proposes that the signal-to-noise ratio of the received signal be evaluated, for example, after an idle slot, that appropriate power adjustment information be produced as a function of this, and that this information be transmitted to the transmitter during the next two timeslots immediately following the idle slot. The transmitter then evaluates the power adjustment information received during these two timeslots and adjusts the transmission power taking account of both power adjustment information items, so that a transmission power adjustment which may have been made on the basis of the first power adjustment information item can still be corrected.

The principle on which the present invention is based can be used both in the uplink, that is to say for transmitting communication information from a mobile station to a base station, and in the downlink, that is to say for the opposite direction, or else for both directions at the same time.

After receiving the power adjustment information in the first timeslot immediately following the idle slot, the transmission power can initially be kept constant, so

that no change is made until the power adjustment information in the second timeslot has been received.

Generally, the power adjustment information transmitted during each timeslot comprises only one bit, with the step width for changing the transmission power

being coded digitally. However, instead of this, the step width can also be coded in analogue form, that is to say the step width then depends, for example, directly analogously on the discrepancy between the received signal level measured in the receiver and a predetermined reference value.

The invention requires no change whatsoever to the specified timeslot format. The combination of the successively transmitted power adjustment information items results in an improvement in the available bit-signal-noise ratio (E_b/N_0). This increased bit-signal-noise ratio allows a greater step width to be provided for power control without any risk of an increased bit error rate more frequently resulting in the transmission power needing to be changed in the wrong direction.

The invention can be used in various types of radio system, although the present invention is of particular interest for mobile radio systems using code division multiplexing methods (code division multiple access CDMA).

The invention will be explained in more detail in the following text with reference to the drawing, based on preferred exemplary embodiments.

Figure 1 shows an illustration to explain the principle on which the invention is based, on the basis of a preferred exemplary embodiment,

Figure 2 shows a general schematic illustration to explain the information transmission in a mobile radio system,

Figure 3 shows the frame and timeslot structure for what is referred to as a downlink connection, according to the present standard of UMTS Standardization, and

Figure 4 shows an illustration to explain the frame structure in what is referred to as the slotted mode.

The principle of power control will first of all be explained in more detail with reference to Figure 2, with Figure 2 illustrating the communication between a base station 1 and a mobile station 2 in a mobile radio system. A connection from the base station 1 to the mobile part 2 is referred to as a downlink or forward link, while a connection from the mobile part 2 to the base station 1 is referred to as an uplink or reverse link. For downlink power control, the respective received signal is evaluated in the mobile station 2, and power adjustment information or power control information is produced as a function of it, and is sent back to the base station 1, so that the base station 1 can set the transmission power as appropriate. For uplink control, the received signal is evaluated in the base station 1, where the power control information is produced, and the mobile station 2 is instructed to carry out power adaptation.

The power control information is in this case transmitted embedded in a predetermined frame structure, depending on the respective mobile radio system.

As an example, Figure 3 shows the frame and timeslot structure for a downlink connection in a mobile radio system which is operated using a code division multiple access method (CDMA). The frame and timeslot structure shown in Figure 3 corresponds in particular to a UMTS mobile radio channel (Universal Mobile Telecommunications System), which is also referred to

as a DPCH (Dedicated Physical CHannel), in accordance with the current state of UMTS Standardization. UMTS is the designation for third-generation mobile radio systems, aiming to provide a worldwide, universal mobile radio standard. According to the UMTS mobile radio standard, the multiple access method is what is referred to as the

WCDMA method (Wideband Code Division Multiple Access).

The frame structure shown in Figure 3 has a duration of 720 ms and comprises, in particular, 72 identically constructed frames 3 with a frame duration of 10 ms, with each frame in turn having 16 timeslots 4, each with a timeslot duration of 0.625 ms. Alternatively, a frame 3 may also comprise 15 correspondingly longer timeslots 4. However, the former situation is assumed in the following text. Each timeslot 4 comprises information which is split between a logical control channel (DPCCH, Dedicated Physical Control Channel) and a logical data channel (DPDCH, Dedicated Physical Data Channel). The DPCCH section comprises a pilot bit sequence 5 and what is referred to a TPC information (Transmitter Power Control) 6 and TFI information (Transmitter Format Identifier) 7. The DPDCH section comprises user data bits 8.

The pilot bit sequence 5 is used for estimating the channel impulse response during what is referred to as a training sequence, and corresponds to a known bit pattern. The receiver can determine or estimate the channel impulse response of the mobile radio channel by comparing the received signal with the known pilot bit sequence.

The TFI information 7 is used for format identification for the respective receiver. The TFI bits are protected by means of their own coding method in accordance with the present WCDMA standard, and are distributed over an entire frame (time period 10 ms) by interleaving. If, for example, the TFI information 7 in each timeslot comprises two bits, then this results in a total of

2*16 = 32 TFI bits per frame, which comprises 16 timeslots, and these are coded by means of what is referred to as a biorthogonal coding method.

The TPC information 6 represents the command, produced by the receiver and transmitted to the transmitter, to adjust the

transmission power. For this purpose, the received power or the signal-to-noise ratio of the received signal is compared with a predetermined reference value in the receiver, and the value for the power adjustment command is determined as a function of the discrepancy. This means that, if the received power exceeds the reference value, a command is produced to reduce the transmission power, while a command to increase the transmission power is produced if the received power is less than the predetermined reference value. Thus, depending on the comparison result, the receiver thus transmits a digital or binary adjustment command to the transmitter. In this case, a command to increase the transmission power (power up command) is coded by a 1, while a command to reduce the transmission power (power down command) is coded by a zero. In each case, the adjustment command is transmitted to the transmitter after appropriate modulation. In accordance with the currently discussed WDCMA Standard for UMTS mobile radio systems, the transmission is carried out by means of QPSK modulation (Quadrature Phase Shift Keying), as a result of which the binary 1 or 0, respectively, is mapped onto the value -1 or +1, respectively, with subsequent spreading of the power control signal.

The power adjustment or power control information thus generally comprises only one bit, which indicates whether the transmission power should be increased or decreased at the transmission end. In order to allow this bit to be transmitted with a sufficiently low error probability, the bit is transmitted repeatedly within the TPC field 6. The TPC information shown in Figure 3 in consequence comprises, for example, the

three bits which are transmitted successively with identical information content.

However, despite the repeated transmission of the TPC bits within the TPC field 6, the error rate is increased by the previously described slotted mode or compressed mode. In order to counteract this, before [lacuna]

information 6 to be transmitted repeatedly, with this being done especially during the two timeslots 4 which immediately follow the idle slot 9.

In order to explain this principle, Figure 1 shows, by way of example, the structure of the already previously mentioned DPCCH control channel (see Figure 3) in a frame, assuming that the timeslots #n shown in Figure 1, is the timeslot immediately following is an idle slot, that is to say a section which is not filled with information. The profile of the transmission power, which is set in the transmitter as a function of the respectively transmitted TPC information, is shown underneath the timeslot structure.

In the receiver, the signal-to-noise ratio of the signal being received from the transmitter at that time is measured in order to determine the TPC or power adjustment information to be transmitted during the timeslot #n, is compared with a reference value and is used to produce the TPC information TPC_n. This TPC information is transmitted to the transmitter during the timeslot #n, where it is decoded and used to adjust the transmission power. In this case, it is possible to wait first of all in the transmitter for reception of the TPC information TPC_{n+1} transmitted during the next timeslot #n+1, before finally setting the transmission power to the desired value, so that it is recommended that the transmission power initially be set in the transmitter in accordance with a "normal" nominal step width, which corresponds to a normal E_b/N_0 ratio, after receiving the TPC information TPC_n. This step width is indicated by ΔP_n in Figure 1, and corresponds to the difference between the instantaneous

transmission power P_{n-1} and the transmission power P_n set after reception of the TPC information TPC_n. The value 0 may also be chosen as the step width ΔP_n after reception of the power adjustment information TPC_n, in order to keep the transmission power constant until the power adjustment information TPC_{n+1} is received, since it is then possible to make a decision

on the transmission power to be set, with greater reliability.

In order to produce the TPC information to be transmitted during the next timeslot #n+1, the TPC information from the previous timeslot is simply repeated, that is to say $TPC_{n+1} = TPC_n$, rather than evaluating the signal-to-noise ratio of the transmission signal once again. In this way, the ratio E_b/N_0 can be increased since, after receiving the timeslot #n+1, the TPC information TPC_{n+1} can be combined with the already previously received TPC information TPC_n, and the transmitter is thus able to set the transmission power to the desired value with greater reliability. If, for example, the transmitter identifies the fact that the decision made as a consequence of the most recently received TPC information was incorrect, this can now be corrected. As shown in Figure 1, the transmitter can now also change the transmission power with a larger step width, thus reducing the risk of a further deterioration being caused after an incorrect TPC decision. This is indicated in Figure 1 by ΔP_{n+1}, with both ΔP_n and ΔP_{n+1} indicating the step width with respect to the transmission power P_{n-1} set after the idle slot.

The principle, mentioned above, of repeated transmission of the same TPC information during successive timeslots can be applied not only to the first time after an interruption in the power control by the idle slot, but also during a normal connection. In this case, this is of particular interest for those situations in which the transmission channel does not change so fast with time, since the disadvantage,

associated with the method, of an increased delay in the power control can then be more than compensated for by the advantage of better quality of the transmitted power adjustment information. Since the smallest step width for power control is currently 1 dB and, for implementation reasons, smaller

values are not suitable for use in mobile stations, this provides a possible way to reduce the power control rate.

Furthermore, the invention can be used to transmit the power adjustment information with a smaller number of TPC bits. Although this reduces the bit-signal-noise ratio (E_b/N_0), this can be compensated for, however, by the advantage of the invention, namely by increased transmission reliability. The use of a small number of TPC bits is advantageous to the extent that this reduces what is referred to as the overhead, and the efficiency can thus be improved.

Furthermore, the present invention can also advantageously be used for what is referred to as a soft handover. In this case, the mobile station 2 transmits and receives data from and to a number of base stations 1. To detect the user data, the received signals from all the connections are combined, thus allowing the power of each individual connection to be reduced. The TPC power adjustment commands may, however, in general not be combined, since the TPC power adjustment commands sent from different base stations 1 (via a downlink) need not be identical. Since the TPC power adjustment commands must also be evaluated very quickly, it is also generally impossible to combine them in the uplink. Otherwise, intolerable delays would occur, caused by the corresponding information being passed on from one base station 1 to another base station 1. In addition to increasing the power level of the number of TPC bits, this could be overcome by use of the present invention.

Finally, the previously described invention can also be combined with the principle of analogue transmission of the step width for adjustment of the transmission power. In this case, the transmission power to be set in the transmitter and the

corresponding step width are coded in analogue form rather than digitally, that is to say the power adjustment information is in each case set in analogue form depending on the discrepancy between the measured received signal level and the predetermined reference value, for example the pilot bit reception level. A discrepancy that is twice as great between the received signal level and the reference value thus results in a step width which is twice as large.

Patent Claims

1. A method for controlling the transmission power in a radio system, with information being transmitted, embedded in a frame and a timeslot structure (3, 4), between a transmitter (2; 1) and a receiver (1; 2), with a signal, which is received by the receiver (1; 2) via a transmission channel in the radio system, from the transmitter (2; 1) being evaluated and power adjustment information (6) being produced as a function of this in each timeslot (4) and being sent to the transmitter (2; 1), and with the transmission power in the transmitter (2; 1) being adjusted as a function of the power adjustment information (6), characterized in that identical power adjustment information (6) is transmitted from the receiver (1; 2) to the transmitter (2; 1) in a number of successive timeslots (4).

2. The method as claimed in claim 1, with the information being transmitted in compressed form in a specific frame (3), so that there is a section (9) which is not filled with information within this frame (3), characterized in that, following a section (9) of a frame (3) which is not filled with information, the receiver (1; 2) transmits identical power adjustment information (6) to the transmitter (2; 1) in a number of successive timeslots (4).

3. The method as claimed in claim 2, characterized in that, following the section (9) which is not filled with information, the receiver (1; 2) transmits identical power adjustment information (6) to the transmitter (2; 1) in two successive timeslots (4).

4. The method as claimed in claim 3,
characterized
in that the transmission power in the transmitter (2; 1) is adjusted as a function of both power adjustment information (6) received in the first timeslot (4) following the section which is not filled with information, and power adjustment information (6) which is received in the second section (9) following the section (9) which is not filled with information.

5. The method as claimed in claim 3 or 4,
characterized
in that the signal received by the receiver (1; 2) from the transmitter (2; 1) is evaluated once again only after the transmission of the identical power adjustment information (6) in the first and second timeslots (4) following the section (9) which is not filled with information, and new power adjustment information is produced as a function of this, and is sent to the transmitter (2; 1) in the next timeslot (4).

6. The method as claimed in one of claims 3-5,
characterized
in that the transmission power in the transmitter (2; 1) is changed by a fixed amount (ΔP_n) after receiving the power adjustment information transmitted in the first timeslot (4) following the section (9) which is not filled with information, and in that, after receiving the power adjustment information (6) transmitted during the second timeslot (4) following the section (9) which is not filled with information, and taking account of the power adjustment information (6) transmitted during the first timeslot (4) following

the section (9) which is not filled with information, a power change value (ΔP_{n+1}) is determined, and the transmission power in the transmitter (2; 1) is changed in accordance with this power change value (ΔP_{n+1}) relative to the transmission power (P_{n-1}) set prior to the first change.

7. The method as claimed in claim 6,
characterized
in that the fixed magnitude (ΔP_n) corresponds to the value zero.

8. The method as claimed in one of the preceding claims,
characterized
in that, in the receiver (1; 2), the power adjustment information (6) is produced analogously as a function of the discrepancy between a specific evaluated parameter in the received signal and a corresponding reference value.

9. The method as claimed in one of the claims 2-8,
characterized
in that identical power adjustment information (6) is also transmitted to the transmitter (2; 1) in a number of successive timeslots (4) which do not immediately follow the section (9) which is not filled with information, and
in that the transmission power in the transmitter (2; 1) is adjusted taking account of the power adjustment information received during these timeslots (4).

10. The method as claimed in one of claims 2-9,
characterized
in that identical power adjustment information (6) is transmitted to the transmitter (2; 1) a number of times in successive timeslots (4) following a section (9) which is not filled with information, with the number of repetitions being different on each occasion.

11. The method as claimed in one of the preceding claims,
characterized
in that the method is used during a soft handover in the mobile radio system.

12. A radio system,
having a transmitter (2; 1), and
having a receiver (1; 2) for receiving a signal, which is transmitted via a transmission channel in the radio system, from the transmitter (2; 1), and for evaluating the received signal in order to produce power adjustment information (6) as a function of it, and to send this information (6) to the transmitter (2; 1),
with the transmitter (2; 1) being designed such that it adjusts the transmission power as a function of the power adjustment information from the receiver (1; 2),
with information being transmitted, embedded in a frame and a timeslot structure (3, 4), between the transmitter (2; 1) and the receiver (1; 2), with a signal,
characterized
in that the receiver (1; 2) is designed such that it transmits identical power adjustment information (6) to the transmitter (2; 1) in a number of successive timeslots (4).

13. The radio system as claimed in claim 12,
with the information being transmitted in compressed form in a specific frame (3), so that there is a section (9) which is not filled with information within this frame (3),
characterized
in that the receiver (1; 2) is designed such that it transmits identical power information (6) to the

transmitter (2; 1) in a number of successive timeslots (4) following a section (9) which is not filled with information in a frame (3).

14. The radio systems claimed in claim 13, characterized in that the receiver (1; 2) is designed such that it transmits identical power adjustment information (6) to the transmitter (2; 1) in two

successive timeslots (4) following the section (9) which is not filled with information.

15. The radio system as claimed in claim 14, characterized in that the transmitter (2; 1) is designed such that it adjusts the transmission power as a function of both power adjustment information (6) received in the first timeslot (4) following the section which is not filled with information, and power adjustment information (6) which is received in the second section (9) following the section (9) which is not filled with information.

16. The radio system as claimed in claim 14 or 15, characterized in that the receiver (1; 2) is designed such that it once again evaluates the signal, received by the receiver (1; 2) from the transmitter (2; 1) after the transmission of the identical power adjustment information (6) in the first and second timeslots (4) following the section (9) which is not filled with information, and produces new power adjustment information as a function of this, and sends this information to the transmitter (2; 1) in the next timeslot (4).

17. The radio system as claimed in one of claims 13-16, characterized in that the transmitter (2; 1) is designed such that it changes the transmission power by a fixed amount (ΔP_n) after receiving the power adjustment information transmitted in the first timeslot (4) following the section (9) which is not filled with information and,

after receiving the power adjustment information (6) received during the second timeslot (4) following the section (9) which is not filled with information, and, additionally taking account of the power adjustment information (6) received during the first timeslot (4) following the section (9) which is not filled with information, it determines a power change value (ΔP_{n+1}), and changes the

transmission power in the transmitter (2; 1) in accordance with this power change value (ΔP_{n+1}).

18. The radio system as claimed in claim 17, characterized in that the fixed amount (ΔP_n) corresponds to the value zero, so that after receiving the power adjustment information transmitted in the first timeslot (4) following the section (9) which is not filled with information, the transmitter (2; 1) keeps the transmission power constant until reception of the power adjustment information (6) transmitted in the second timeslot (4) following the section (9) which is not filled with information.

19. The radio system as claimed in one of claims 12-18, characterized in that the receiver (1; 2) is designed such that it produces the power adjustment information (6) analogously as a function of the discrepancy between a specific evaluated parameter in the received signal and a corresponding reference value.

20. The radio system as claimed in one of claims 13-19, characterized in that the receiver (1; 2) is designed such that it also transmits identical power adjustment information (6) to the transmitter (2; 1) in a number of successive timeslots (4) which do not directly follow a section (9) which is not filled with information, and

in that the transmitter (2; 1) is designed such that it adjusts the transmission power taking account of the power adjustment information received during these timeslots (4).

21. The radio system as claimed in one of claims 12-20,

characterized

in that the radio system is a CDMA mobile radio system.

FIG 1

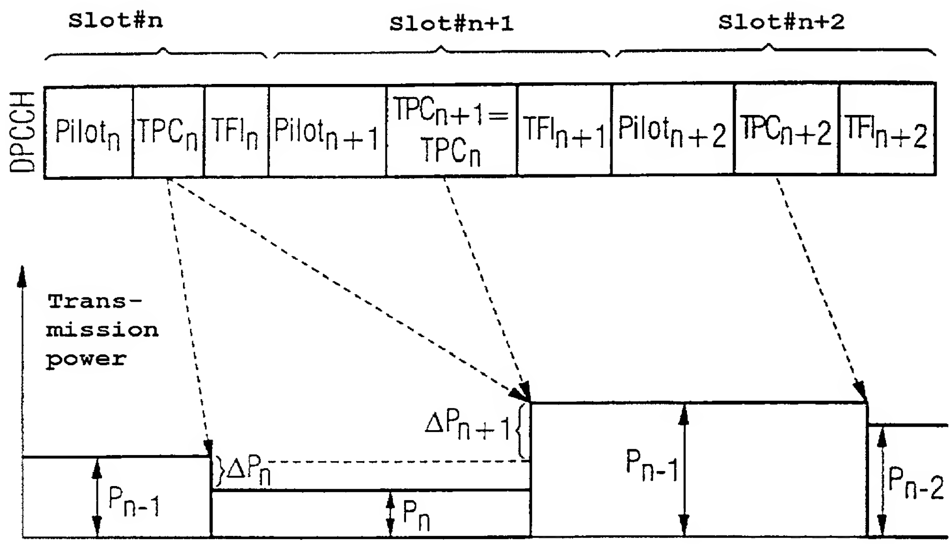

Slot#n
Slot#n+1
Slot#n+2
DPCCH
Pilot$_n$
TPC$_n$
TFI$_n$
Pilot$_{n+1}$
TPC$_{n+1}$= TPC$_n$
TFI$_{n+1}$
Pilot$_{n+2}$
TPC$_{n+2}$
TFI$_{n+2}$
Trans-mission power
ΔP_{n+1}
ΔP_n
P_{n-1}
P_n
P_{n-1}
P_{n-2}

FIG 2

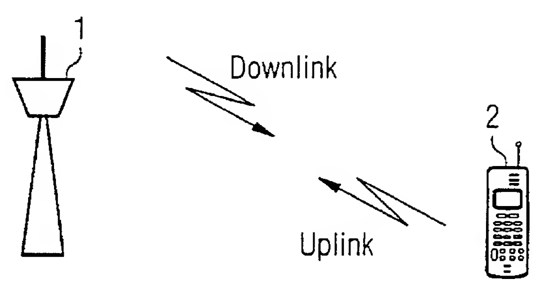

1
Downlink
2
Uplink

FIG 3

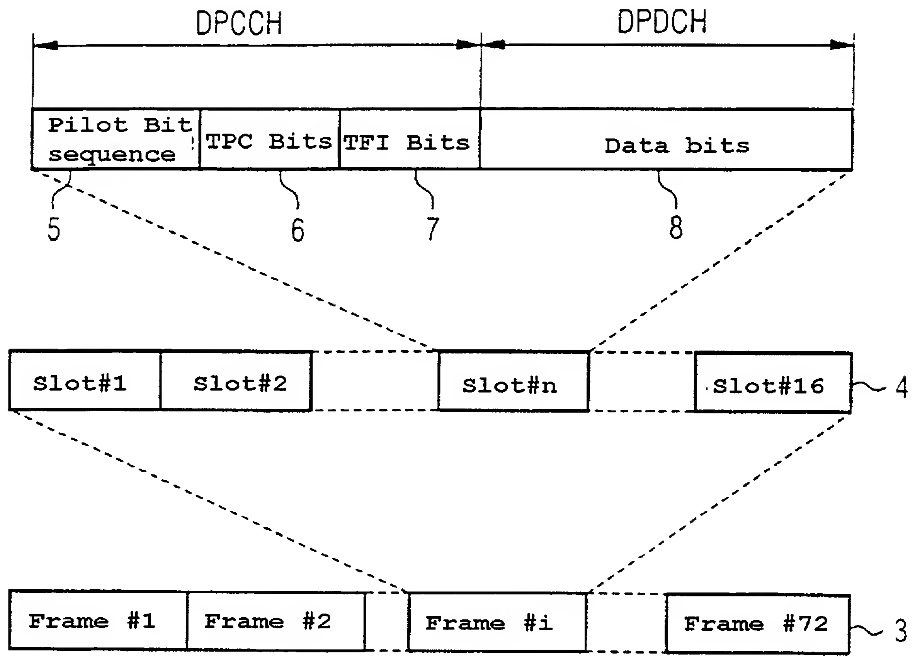
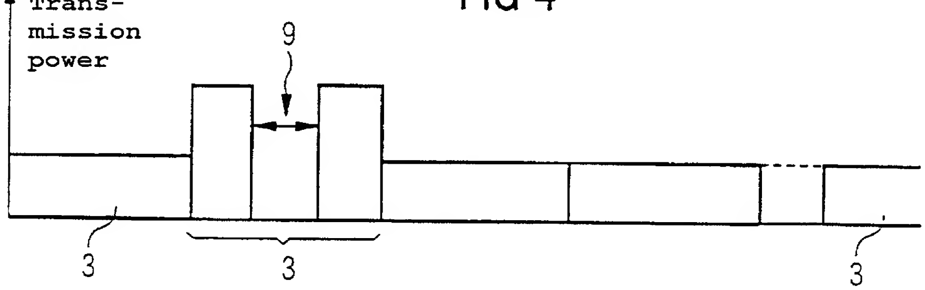

DPCCH
DPDCH
Pilot Bit sequence
TPC Bits
TFI Bits
Data bits
5
6
7
8
Slot#1
Slot#2
Slot#n
Slot#16
4
Frame #1
Frame #2
Frame #i
Frame #72
3

FIG 4


Trans-
mission
power
9
3
3
3

Declaration and Power of Attorney For Patent Application
Erklärung Für Patentanmeldungen Mit Vollmacht
German Language Declaration

Als nachstehend benannter Erfinder erkläre ich hiermit an Eides Statt:

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dass ich, nach bestem Wissen der ursprüngliche, erste und alleinige Erfinder (falls nachstehend nur ein Name angegeben ist) oder ein ursprünglicher, erster und Miterfinder (falls nachstehend mehrere Namen aufgeführt sind) des Gegenstandes bin, für den dieser Antrag gestellt wird und für den ein Patent beantragt wird für die Erfindung mit dem Titel:

Verfahren zur Regelung der Sendeleistung in einem Funksystem und entsprechendes Funksystem

deren Beschreibung

(zutreffendes ankreuzen)
☐ hier beigefügt ist.
☒ am 16.05.2000 als
PCT internationale Anmeldung
PCT Anmeldungsnummer PCT/DE00/01542
eingereicht wurde und am ________
abgeändert wurde (falls tatsächlich abgeändert).

Ich bestätige hiermit, dass ich den Inhalt der obigen Patentanmeldung einschliesslich der Ansprüche durchgesehen und verstanden habe, die eventuell durch einen Zusatzantrag wie oben erwähnt abgeändert wurde.

Ich erkenne meine Pflicht zur Offenbarung irgendwelcher Informationen, die für die Prüfung der vorliegenden Anmeldung in Einklang mit Absatz 37, Bundesgesetzbuch, Paragraph 1.56(a) von Wichtigkeit sind, an.

Ich beanspruche hiermit ausländische Prioritätsvorteile gemäss Abschnitt 35 der Zivilprozessordnung der Vereinigten Staaten, Paragraph 119 aller unten angegebenen Auslandsanmeldungen für ein Patent oder eine Erfindersurkunde, und habe auch alle Auslandsanmeldungen für ein Patent oder eine Erfindersurkunde nachstehend gekennzeichnet, die ein Anmeldedatum haben, das vor dem Anmeldedatum der Anmeldung liegt, für die Priorität beansprucht wird.

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

Method for adjusting transmission power in a radio system and corresponding radio system

the specification of which

(check one)
☐ is attached hereto.
☒ was filed on 16.05.2000 as
PCT international application
PCT Application No. PCT/DE00/01542
and was amended on ________
(if applicable)

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

German Language Declaration

Prior foreign appplications
Priorität beansprucht

Priority Claimed

19928763.5 (Number) (Nummer)	DE (Country) (Land)	23.06.1999 (Day Month Year Filed) (Tag Monat Jahr eingereicht)	☒ Yes Ja	☐ No Nein
(Number) (Nummer)	(Country) (Land)	(Day Month Year Filed) (Tag Monat Jahr eingereicht)	☐ Yes Ja	☐ No Nein
(Number) (Nummer)	(Country) (Land)	(Day Month Year Filed) (Tag Monat Jahr eingereicht)	☐ Yes Ja	☐ No Nein

Ich beanspruche hiermit gemäss Absatz 35 der Zivilprozessordnung der Vereinigten Staaten, Paragraph 120, den Vorzug aller unten aufgeführten Anmeldungen und falls der Gegenstand aus jedem Anspruch dieser Anmeldung nicht in einer früheren amerikanischen Patentanmeldung laut dem ersten Paragraphen des Absatzes 35 der Zivilprozeßordnung der Vereinigten Staaten, Paragraph 122 offenbart ist, erkenne ich gemäss Absatz 37, Bundesgesetzbuch, Paragraph 1.56(a) meine Pflicht zur Offenbarung von Informationen an, die zwischen dem Anmeldedatum der früheren Anmeldung und dem nationalen oder PCT internationalen Anmeldedatum dieser Anmeldung bekannt geworden sind.

I hereby claim the benefit under Title 35. United States Code. §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §122, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occured between the filing date of the prior application and the national or PCT international filing date of this application.

PCT/DE00/01542 (Application Serial No.) (Anmeldeseriennummer)	16.05.2000 (Filing Date D, M, Y) (Anmeldedatum T, M, J)	anhängig (Status) (patentiert, anhängig, aufgegeben)	pending (Status) (patented, pending, abandoned)
(Application Serial No.) (Anmeldeseriennummer)	(Filing Date D,M,Y) (Anmeldedatum T, M; J)	(Status) (patentiert, anhängig, aufgeben)	(Status) (patented, pending, abandoned)

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

German Language Declaration

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Voller Name des einzigen oder ursprünglichen Erfinders: BERNHARD RAAF	Full name of sole or first inventor: BERNHARD RAAF
Unterschrift des Erfinders: Bernhard Raaf Datum 8.11.01	Inventor's signature Date
Wohnsitz: MUENCHEN, DEUTSCHLAND DEX	Residence: MUENCHEN, GERMANY
Staatsangehörigkeit: DE	Citizenship: DE
Postanschrift: MAXHOFSTR. 62	Post Office Addess: MAXHOFSTR. 62
81475 MUENCHEN	81475 MUENCHEN

Voller Name des zweiten Miterfinders (falls zutreffend):	Full name of second joint inventor, if any:
Unterschrift des Erfinders Datum	Second Inventor's signature Date
Wohnsitz ,	Residence ,
Staatsangehörigkeit	Citizenship
Postanschrift	Post Office Address

(Bitte entsprechende Informationen und Unterschriften im Falle von dritten und weiteren Miterfindern angeben).

(Supply similar information and signature for third and subsequent joint inventors).